Hurricane and Severe Storm Sentinel (HS3)

Airborne Sciences and the background to HS3

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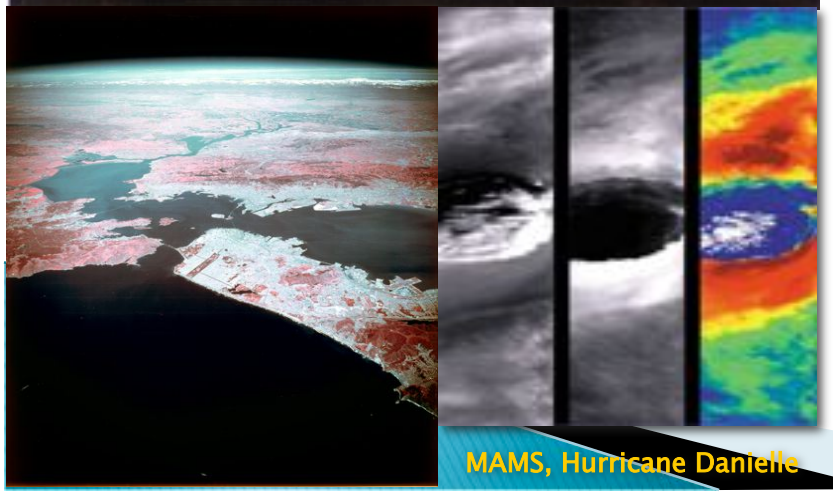
Questions

- Why does NASA do airborne science?
- What sort of platforms do we use?
- Why do we investigate hurricanes?
- What are our science questions?
- What do we need to answer our questions?

Why does NASA do airborne science?

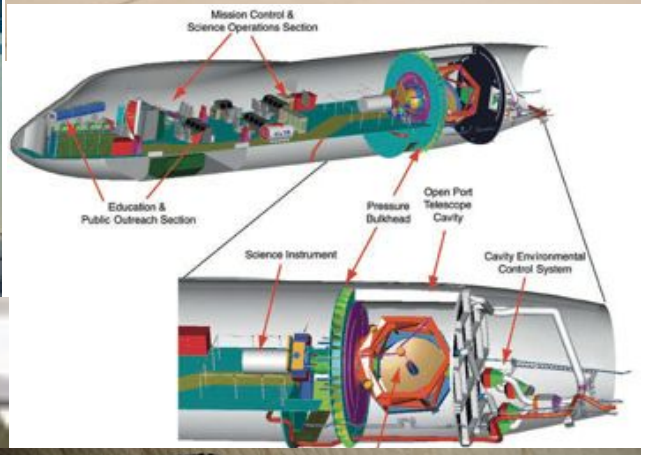
- Satellites can't do it all
  - Process studies for focused science questions
- Some science requires 24-hour measurements
  - Monitoring and Applications
- Satellites instruments can't be brought back
  - Satellite validation
- How do we take a instrument concept from the lab to space?
  - Space-based instrument test-beds, algorithm development, IIP implementation

What planes does NASA operate?



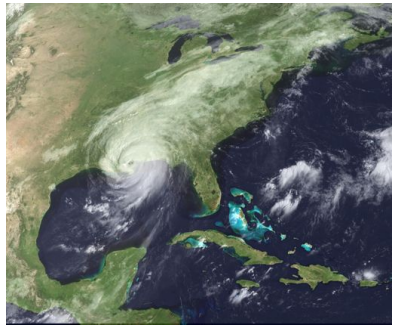
MAMS, Hurricane Danielle

Reconfigurable flying laboratories



Why look at hurricanes?

- Close to 100 million Americans now live within 50 miles of a coastline, thus exposing them to the potential destruction caused by a landfalling hurricane.
- 2011: Irene (Cat 3 to 1), 56 deaths and an estimated 15.6B in damages
- 2008: Gustav (Cat 2, 26 deaths), Ike (17 deaths, 2 million homes without power)
- 2005: Katrina (~1800 deaths, 100B in damages)



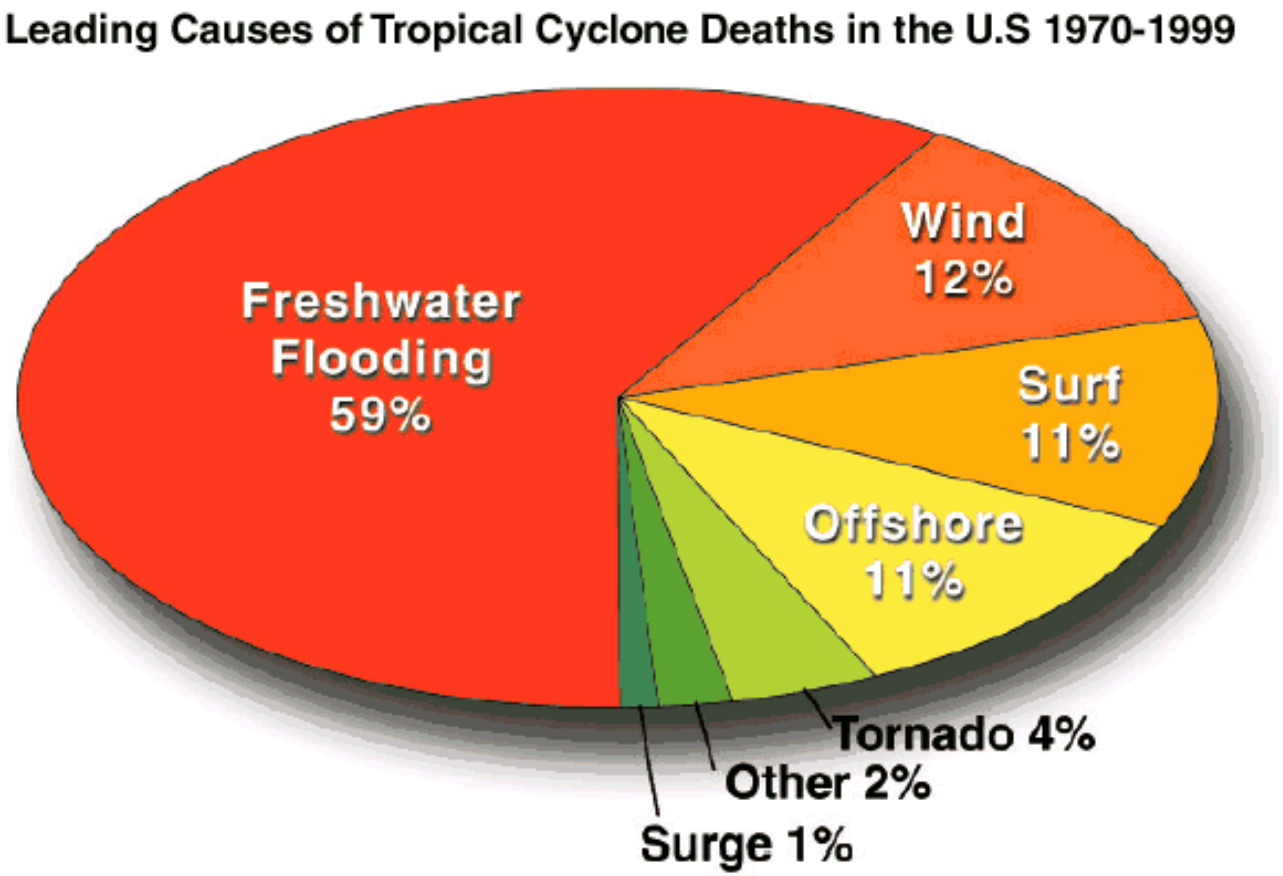
Why look at hurricanes?

Category	Max sustained wind speed		
	mph	knots	damage
1	74-95	64-82	Tree damage, small boats torn from moorings, roads flooded
2	96-110	83-95	Roofing, windows, doors boats, piers, mobile homes
3	111-130	96-113	Some structural damage to buildings, flooding, wave damage
4	131-155	114-135	Lots of structural damage, major flooding, storm surge
5	156+	136+	Catastrophic, building failures

Hurricane dangers!

- Hurricanes present many dangers:
  - High winds
  - Storm surge
  - Tornadoes
  - Flooding

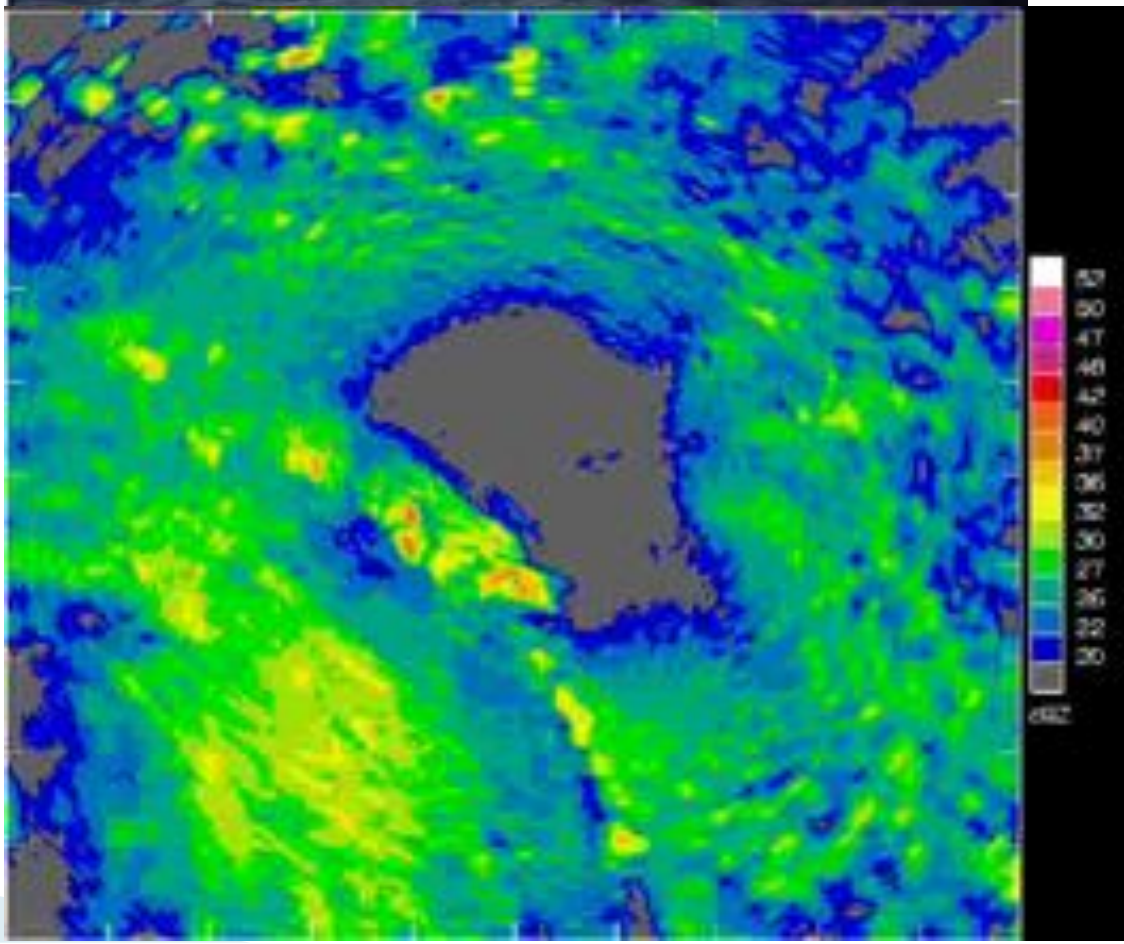
Hurricane dangers!



Source: Edward Rappaport—Chief, Technical Support Branch, Tropical Prediction Center

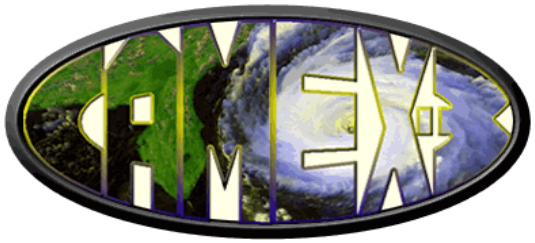
Aircraft

- Aircraft recon since 1940's
- NOAA recon since 1956
- Information on hurricane position, intensity and structure



NASA Hurricane Field Experiments

1998



2001

2005

2006

2010

NASA field campaigns have helped develop a better understanding of hurricane properties, including inner core dynamics, rapid intensification and genesis

- We do field experiments to accomplish:
  - calibration/validation of satellite sensor
  - evaluation of new sensor concepts
  - process studies

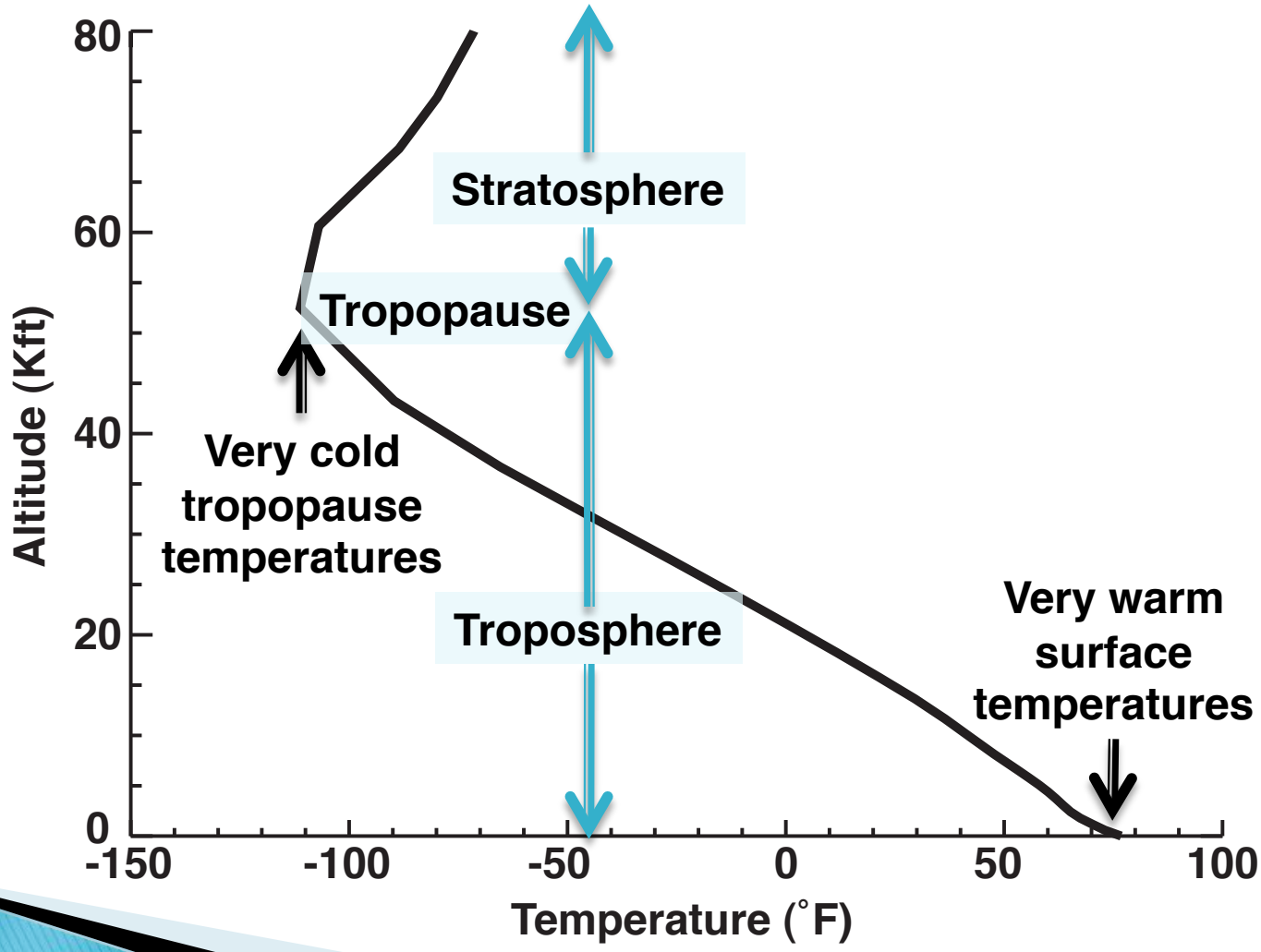
What are our questions?

- What impact does the large-scale environment, particularly the Saharan Air Layer (SAL), have on intensity change?
- What is the role of storm internal processes such as deep convective towers?
- What determines whether a storm undergoing transition to an extratropical storm intensifies?
- To what extent are these intensification processes predictable?

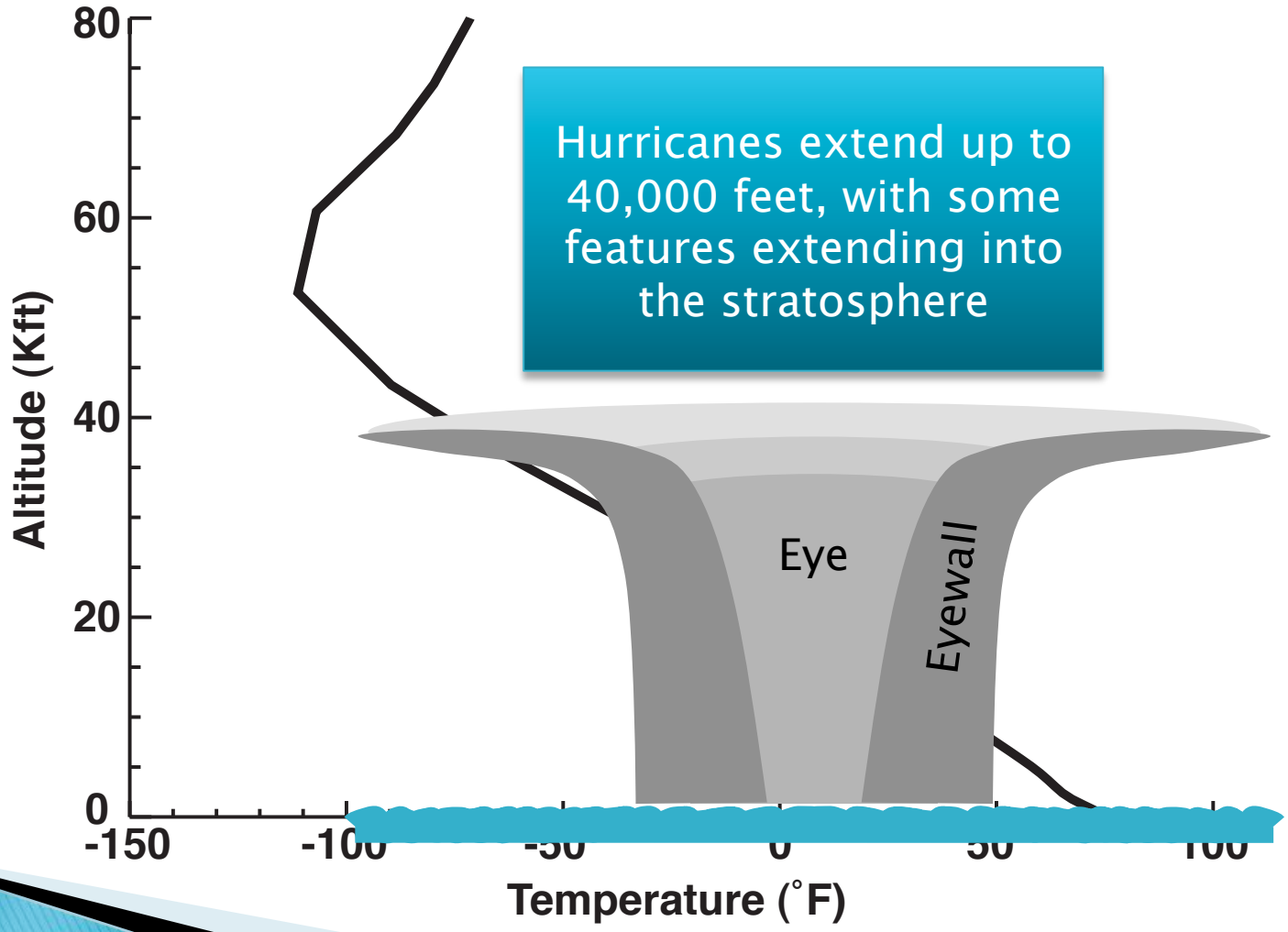
What do we need?

- A high altitude platform to observe the entire hurricane
- A long range platform to enable us to sample any target
- A platform with enough duration to provide more than just a “snapshot”.

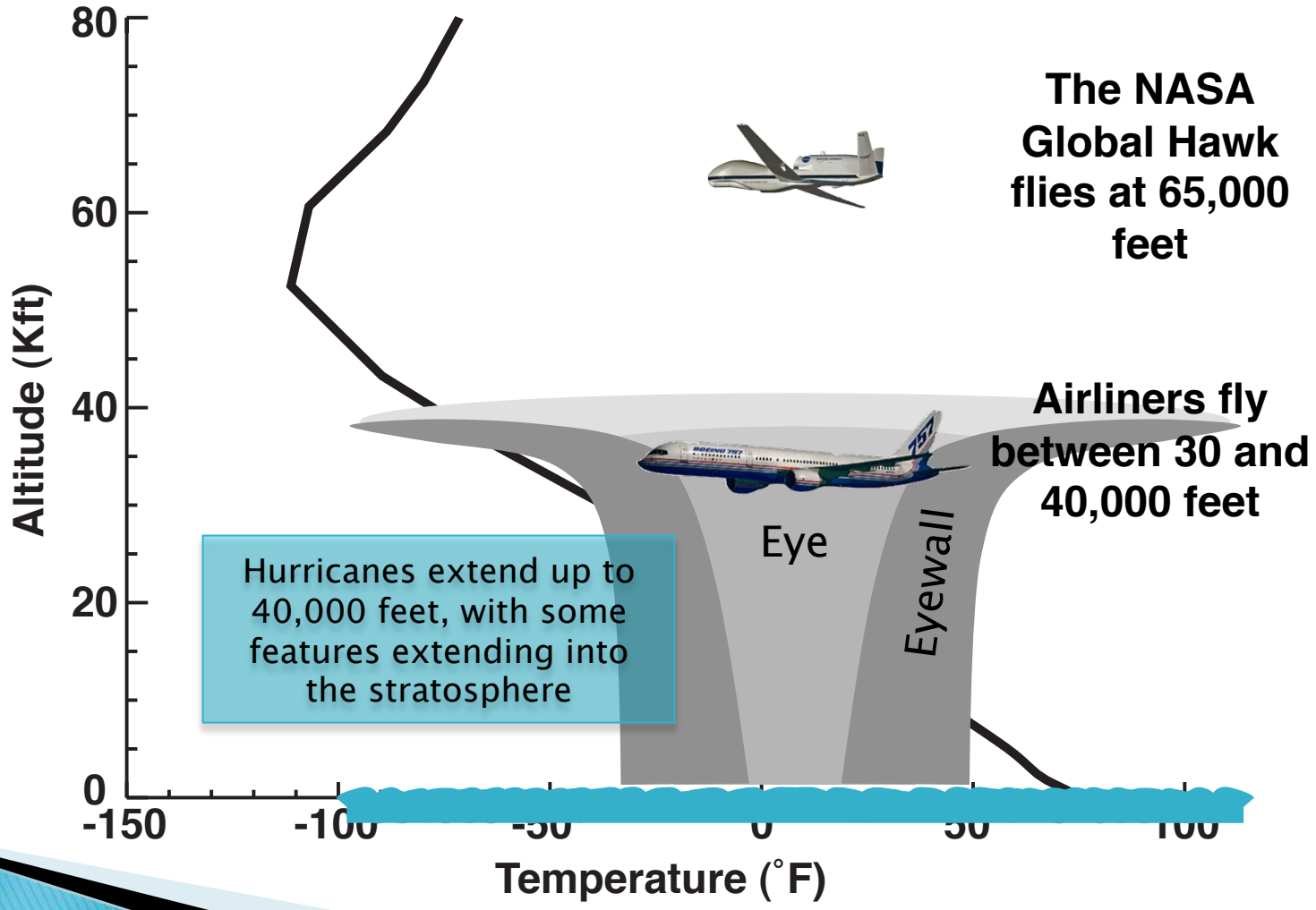
Basics – tropical temperature



Basics – tropical temperature

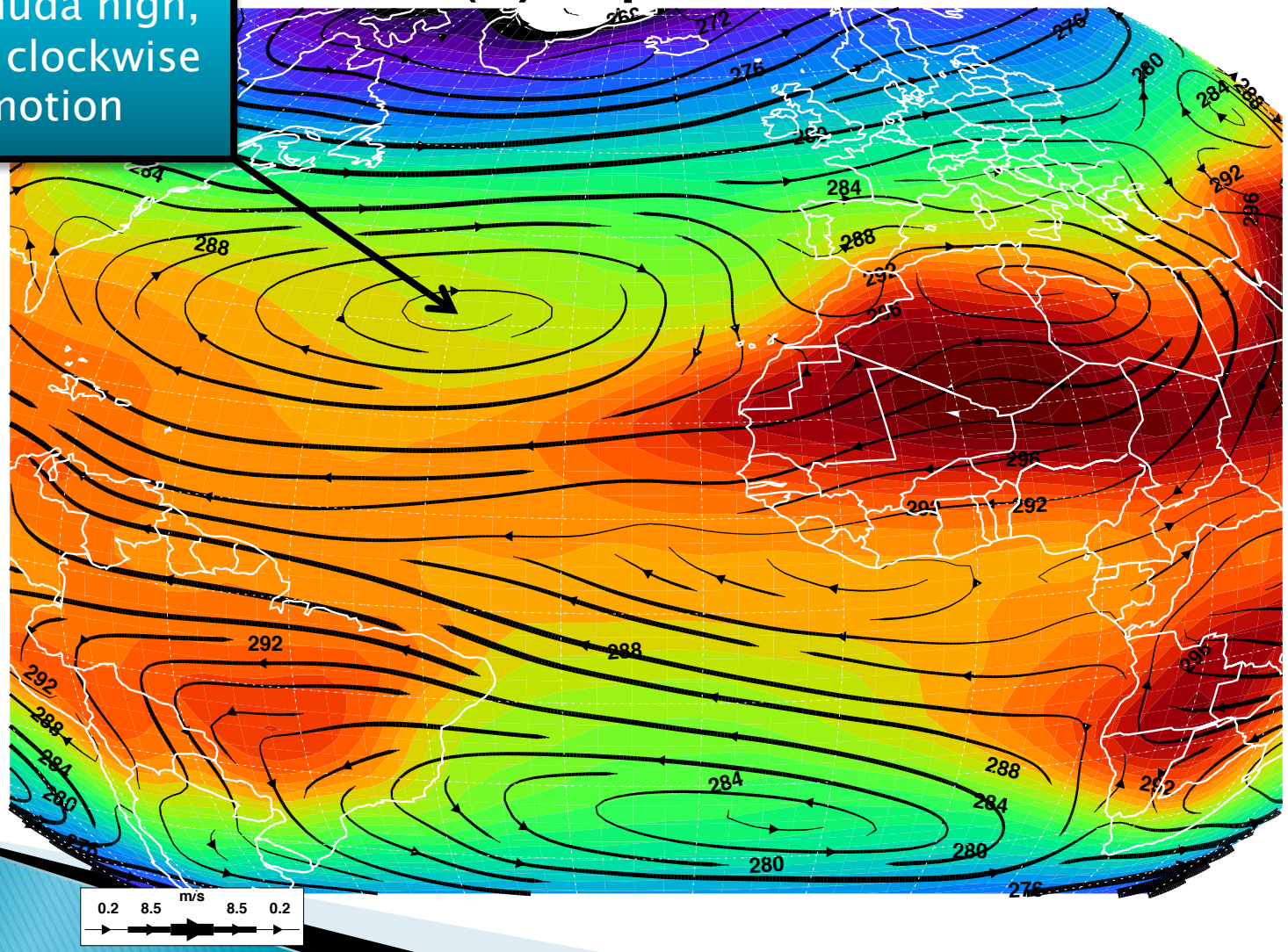


We need a platform that can overfly hurricanes to see the whole structure



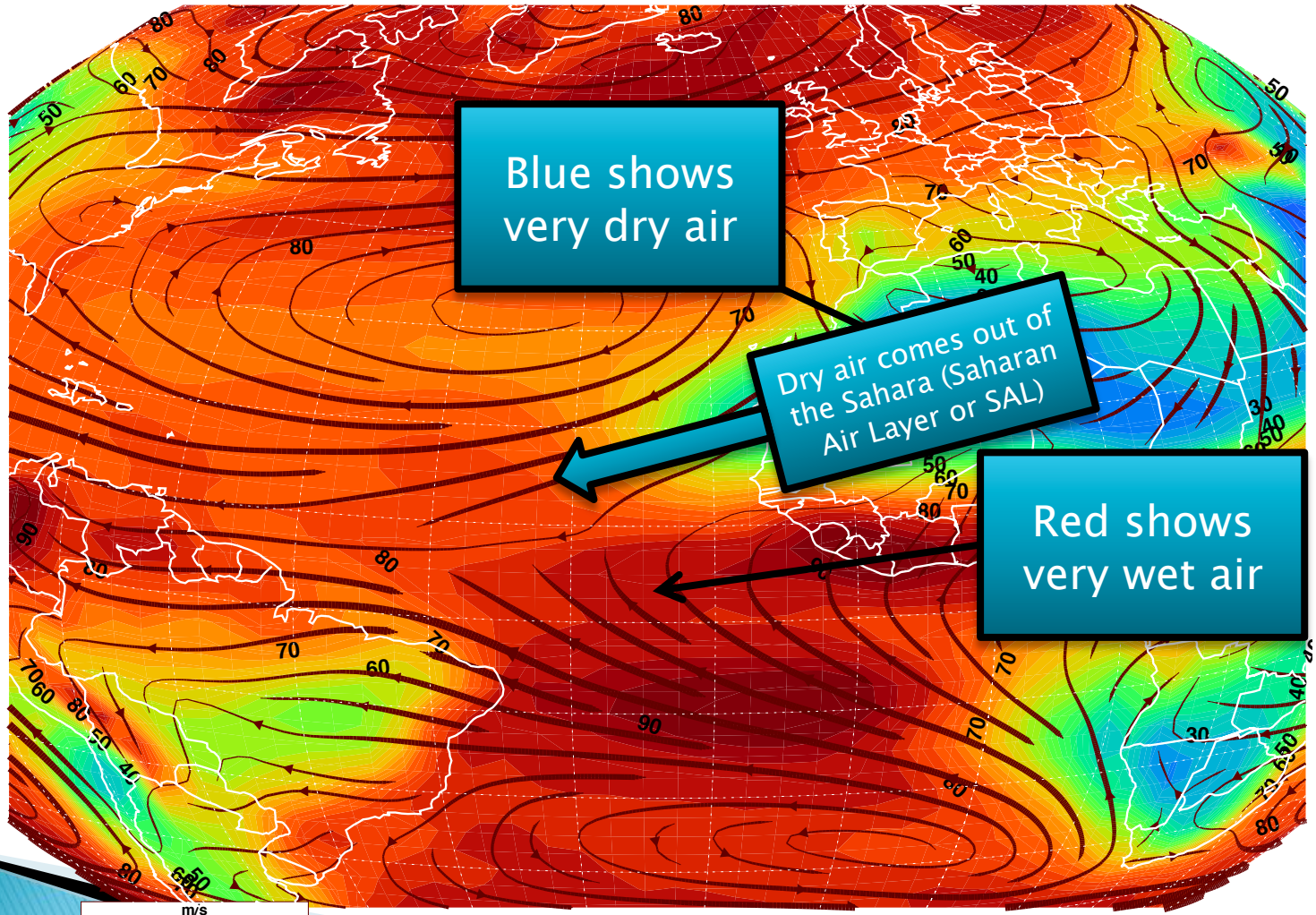
Basics – tropical air motion

Bermuda high, note clockwise motion

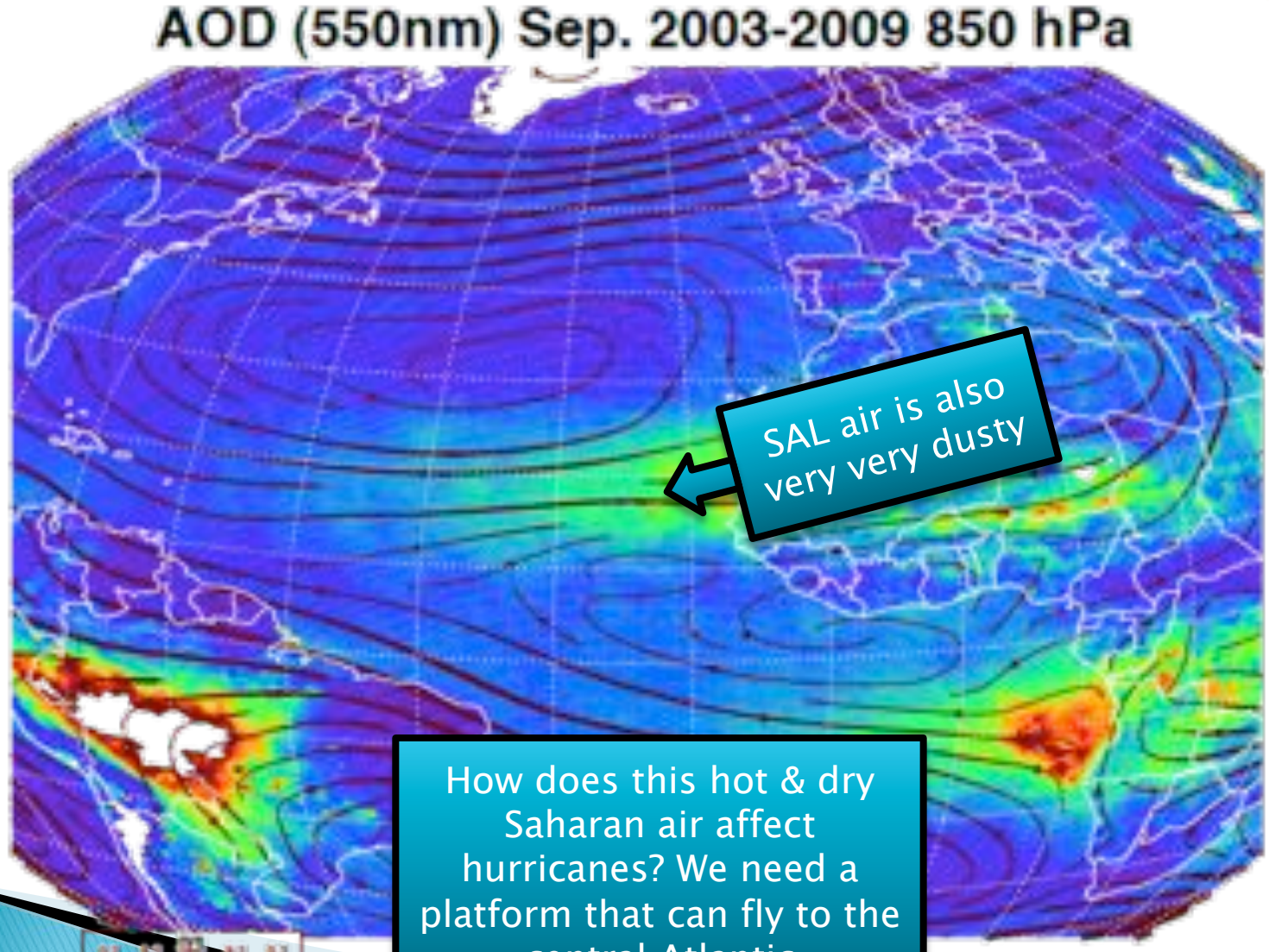


Basics – tropical air humidity

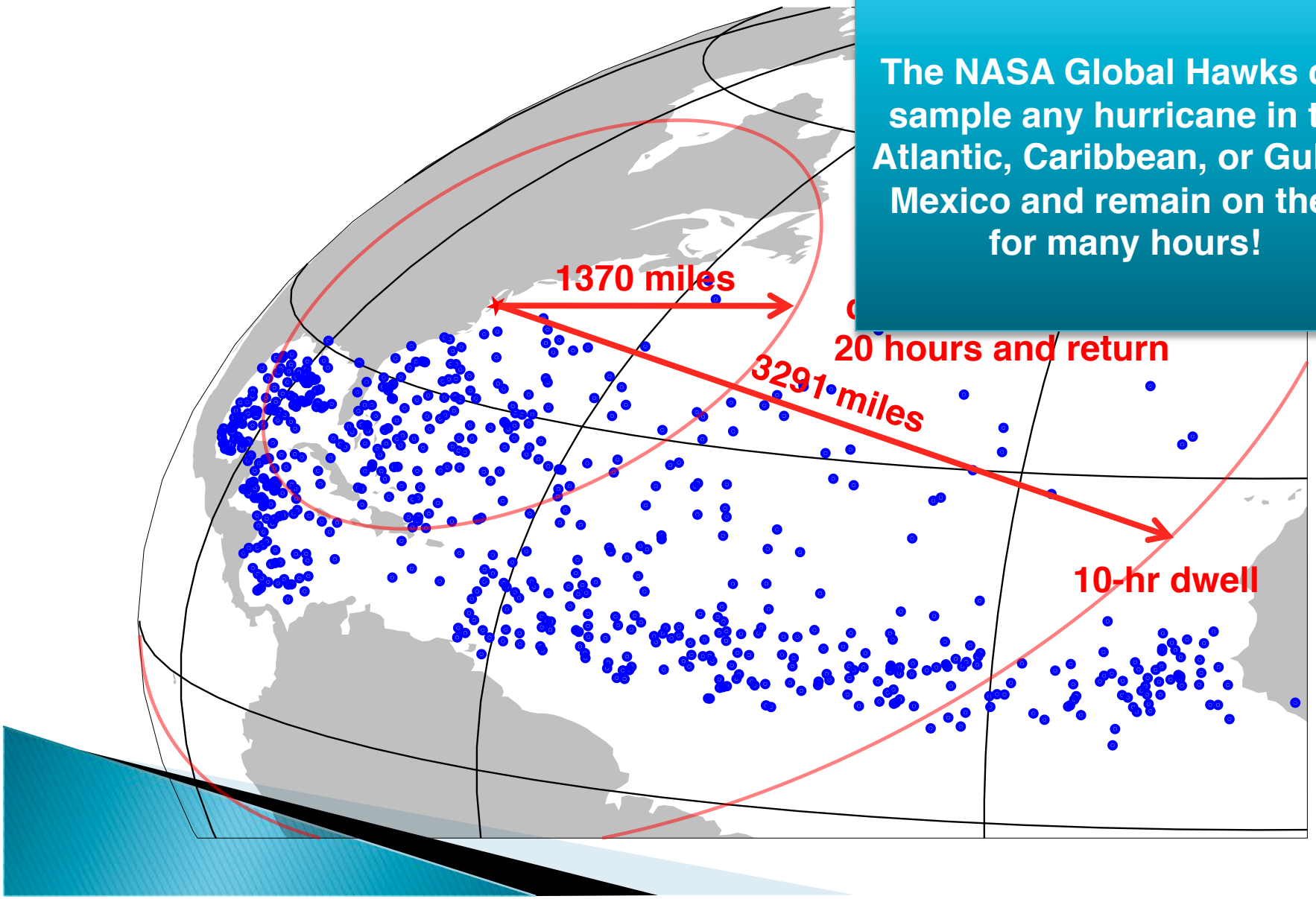
Relative Humidity (%) Sep. 2.5 kft



Basics – tropical air dust



Where do hurricanes form?

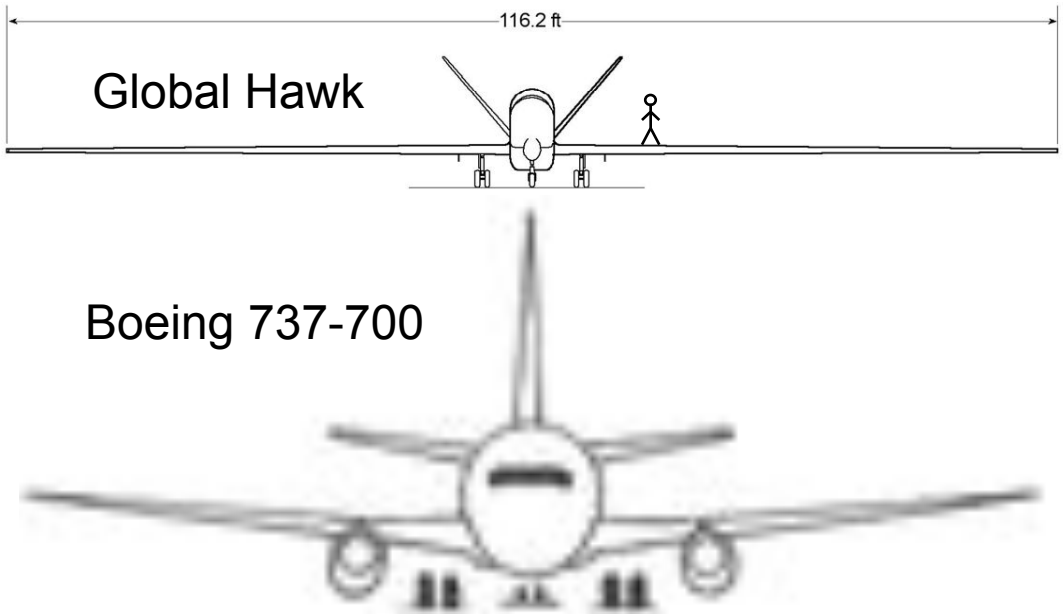


The NASA Global Hawks can sample any hurricane in the Atlantic, Caribbean, or Gulf of Mexico and remain on them for many hours!

What is the NASA Global Hawk UAS?

Where's the pilot?

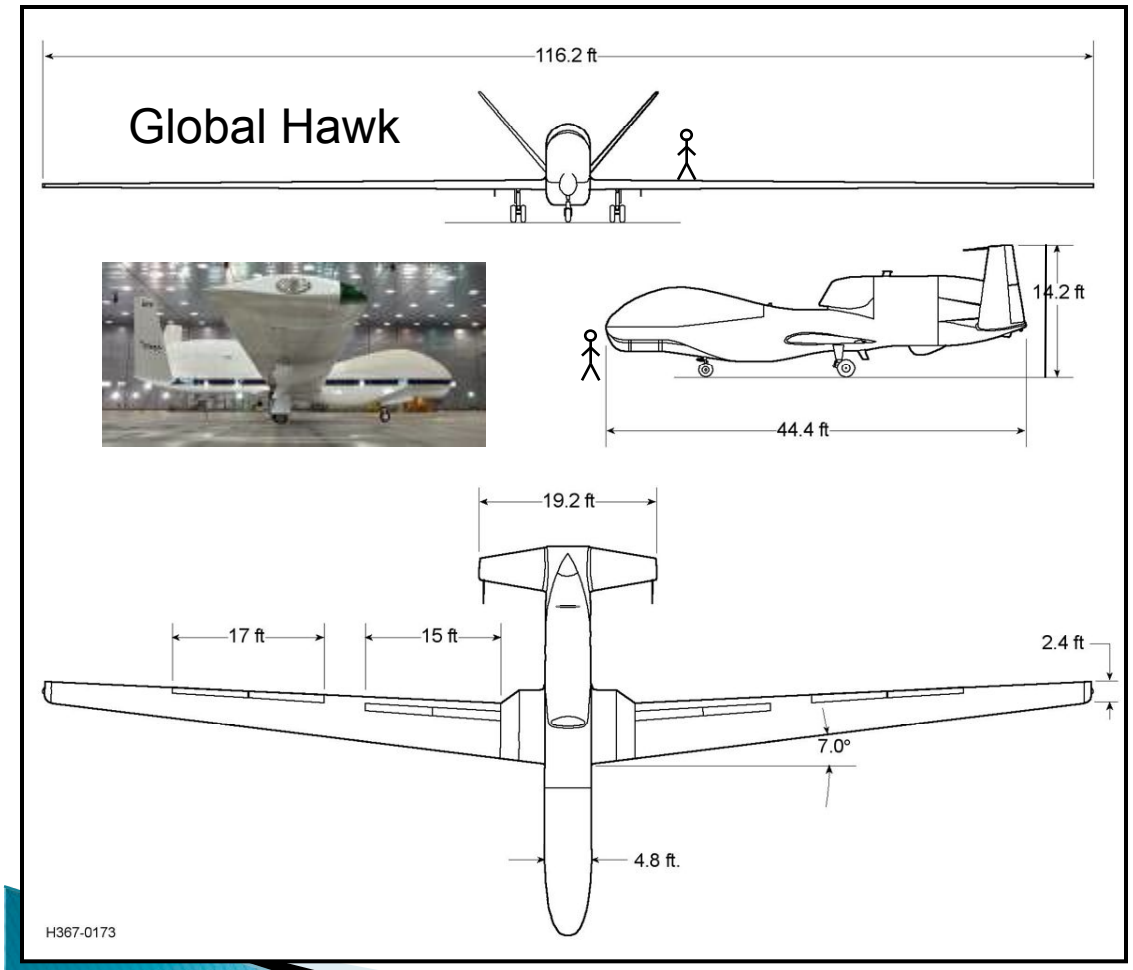
GH numbers



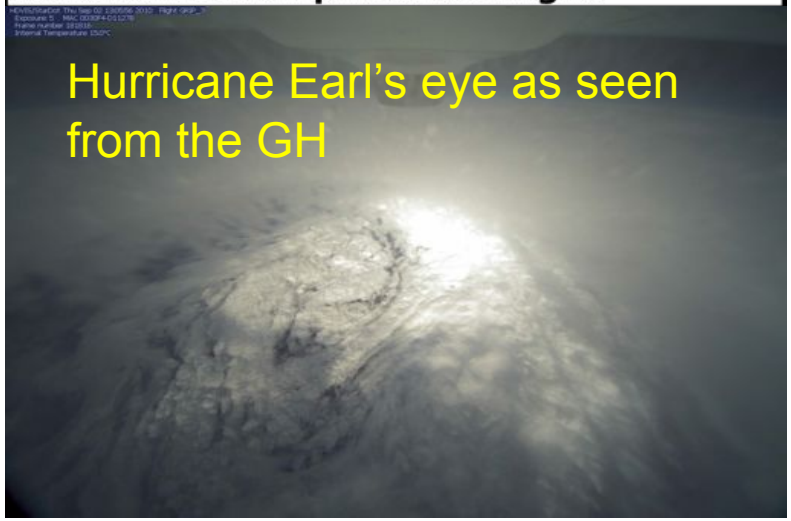
737 wingspan = 112 feet
ER-2 length = 110 feet

GH numbers

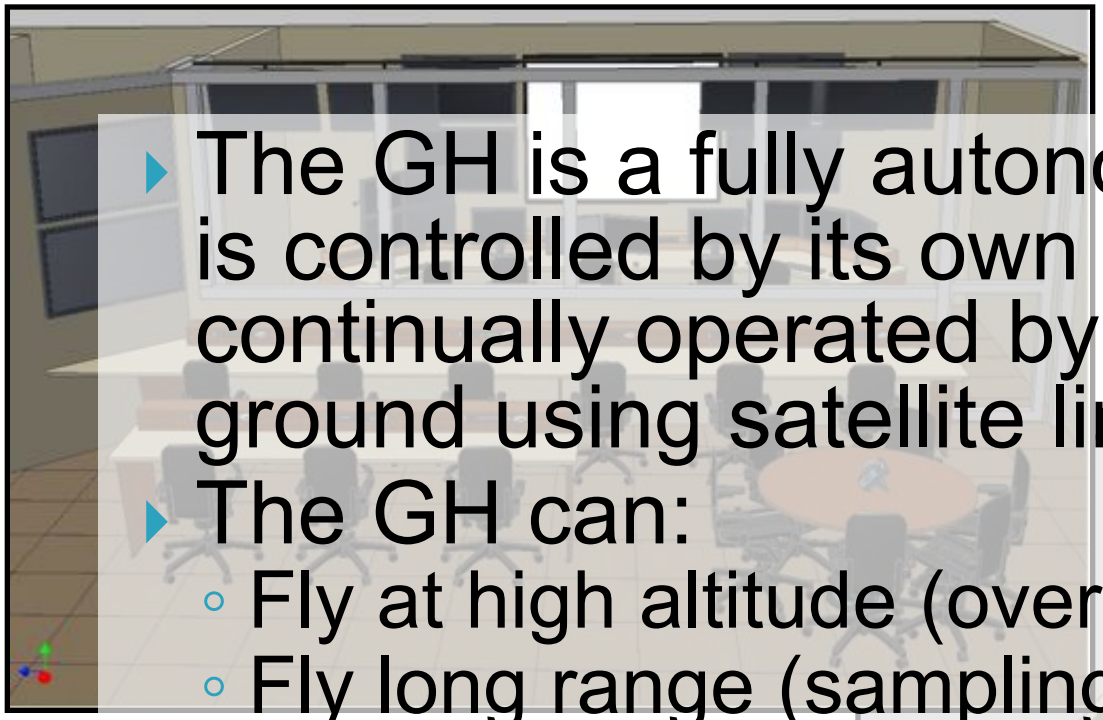
737 wingspan = 112 feet
ER-2 length = 110 feet



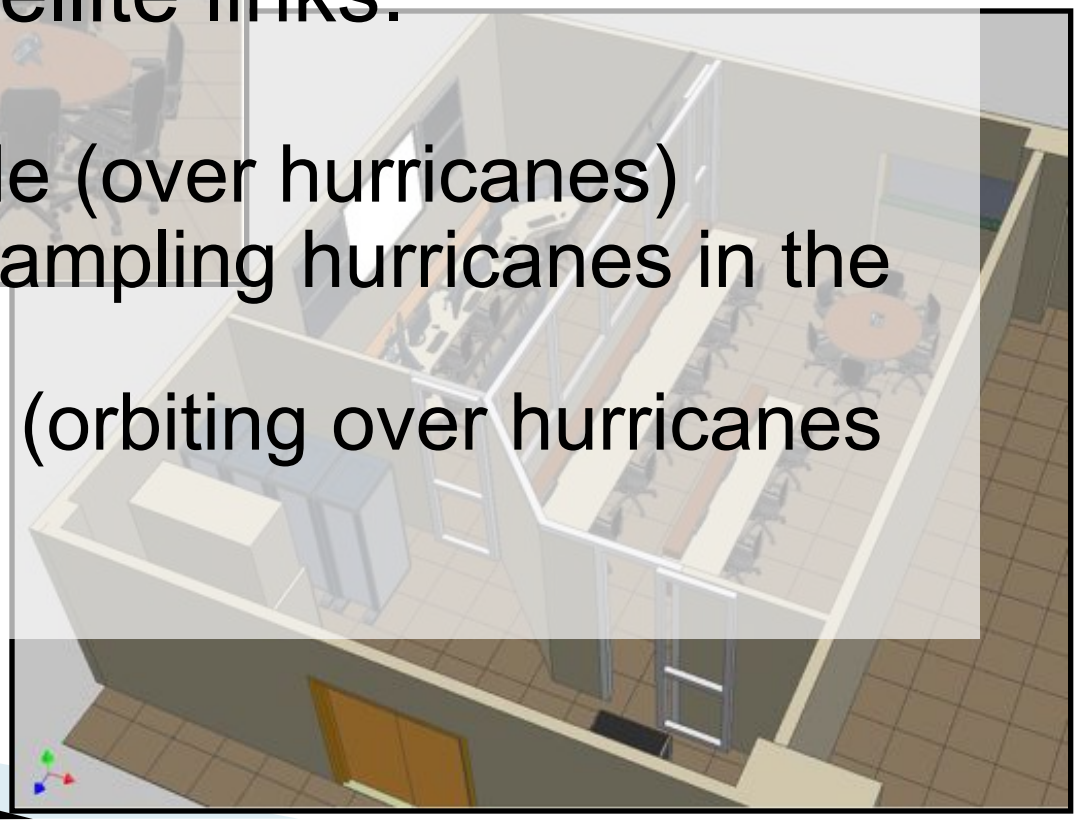
Range	>11,500 mi
Endurance	>30 hours
Maximum Altitude	65,000 feet
Gross Weight	26,750 lbs
Fuel Capacity	15,300 lbs
True Airspeed	385 mph
Payload Weight	1500 lbs
Payload Volume	>100 ft3
Airfield requirement	8,000 x 150 feet
Fuel	JP-8
Autonomous all phases of flight	



Global Hawk Ground Control Station Views



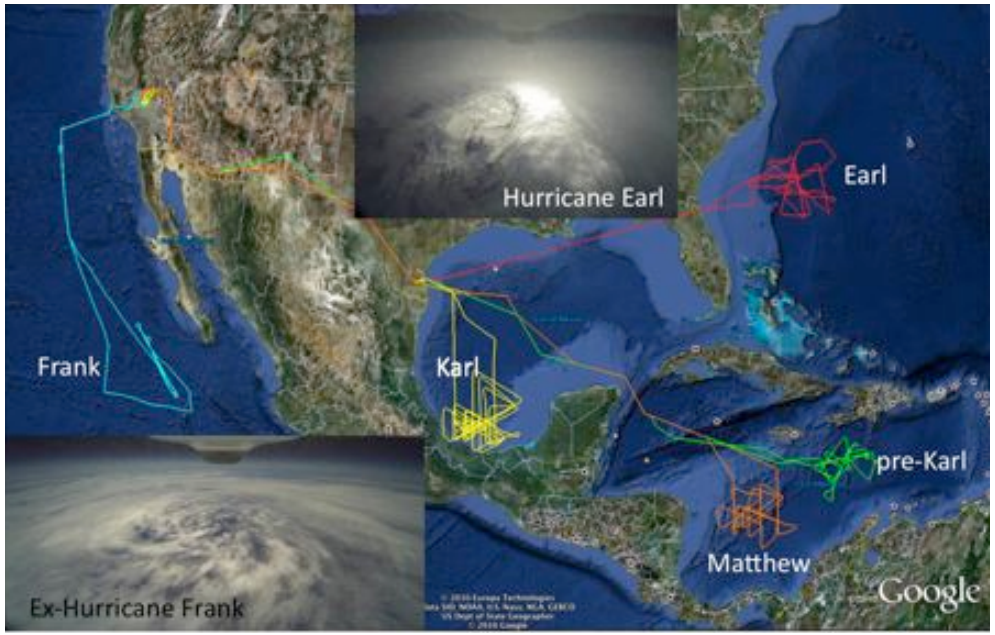
- The GH is a fully autonomous UAS that is controlled by its own software and is continually operated by pilots on the ground using satellite links.
- The GH can:
  - Fly at high altitude (over hurricanes)
  - Fly long range (sampling hurricanes in the distant Atlantic
  - Fly long-duration (orbiting over hurricanes for many hours)



GRIP Accomplishments

- Major cases
  - Multi-day flights of covering the genesis of Karl Matthew, and non re-genesis of Gaston
  - DC-8 flights for RI of Earl (from Cat1 to Cat4)
  - DC-8 & GH flights of RI of Karl (from Cat1 to Cat3)

- Technical Achievements
  - First GH flight over a hurricane
  - 20 GH eye crossings in one flight over Karl



Summary

- NASA employs aircraft in a variety of roles to support its satellite missions, develop new instrumentation, and to answer science questions
- The Global Hawk unmanned aircraft system (UAS) is the newest addition to the NASA fleet
- Questions about how hurricanes form and intensify require a heavy lift, long-endurance, long-range, and high-altitude platform
- The Hurricane and Severe Storm Sentinel Mission will use two Global Hawks to explore hurricanes in the Atlantic-Caribbean-Gulf region in the years 2012, 2013, and 2014